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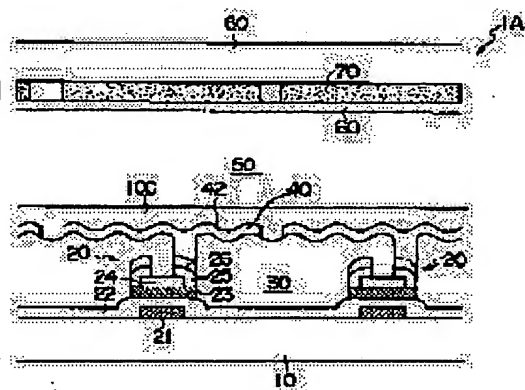
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(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:

PURPOSE: To improve the efficiency of taking out reflected light to the outside of the reflection type liquid crystal display device.

CONSTITUTION: This reflection type liquid crystal display device 1A is provided with TFTs 20 which serve as pixel selection switches on a glass substrate 10. Acryl resin layers 30 having ruggedness are disposed on the surfaces of these TFTs 20. Reflection electrodes 40 made of Al are laminated thereon. The surfaces 42 of the reflection electrodes 40 are roughened by receiving the influence of the rugged surfaces of the acryl resin layers 30. A transparent insulating film 100 is provided atop the reflection electrodes 40 and a liquid crystal layer 50 contg. dyestuff, transparent electrodes 60, color filters 70 and a glass substrate 80 are laminated thereon. The transparent insulating film 100 is formed out of a material having the refractive index higher than the refractive index of the liquid crystal layer 50. The ratio at which the light is absorbed by the liquid crystal layer is decreased by this constitution. The efficiency of taking out the light to the outside is thus improved.



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CLAIMS

[Claim(s)]

[Claim 1] The reflective mold liquid crystal display characterized by preparing a transparence insulating layer with a bigger refractive index than said liquid crystal layer between said reflective pixel electrodes and said liquid crystal layers in the reflective mold liquid crystal display which comes to pinch the liquid crystal layer containing coloring matter between the reflective pixel electrode with which the front face was split-face-ized, and a transparent electrode.

[Claim 2] The reflective mold liquid crystal display according to claim 1 characterized by separating said transparence insulating layer for said every reflective pixel electrode.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to a reflective mold liquid crystal display.

[0002]

[Description of the Prior Art] Drawing 4 is the drawing shown by making structure of the conventional reflective mold liquid crystal display into a cross section. The pixel selecting switch 20 by the thin film transistor (TFT) is formed on the transparence insulation substrates 10, such as glass, and the reflective mold liquid crystal display in which the whole is shown with a sign 1 is covered in the acrylic resin layer 30. The aluminum reflector 40 which has the split-face-ized front face 42 is arranged in the top face of the acrylic resin layer 30, and the guest host mold liquid crystal layer 50 containing the black color molecule 52 is formed in the upper part. The top face of the liquid crystal layer 50 is covered with the opposite transparent electrode 60, and a color filter 70 is formed on the opposite transparent electrode 60. The top face of a color filter 70 is covered with the transparence insulation substrates 80, such as glass. In the condition that the pixel selecting switch 20 is not chosen, an electrical potential difference is not impressed to the liquid crystal layer 50, but liquid crystal 50A will be in a focal conic array condition. In this condition, light is absorbed with the black color molecule 52 in liquid crystal, and that pixel serves as a black display. Where the pixel selecting switch 20 is chosen, an electrical potential difference is impressed to the liquid crystal layer 50, and, as for liquid crystal 50B, the direction of a major axis of a liquid crystal molecule gathers in the direction of electric field. In this condition, the light absorption in the liquid crystal layer 50 is not produced. Therefore, the light which carried out incidence is reflected by the aluminum reflector 40, and the color of the color filter 70 on it is displayed.

[0003] The aluminum reflector 40 is formed on TFT20, and a numerical aperture is enlarged in order to raise the brightness in the case of color specification conventionally. Although means, such as enlarging the reflection factor of the aluminum reflector 40 using for a color filter 70 the ingredient which has high permeability, and by forming the aluminum reflector 40 on the acrylic resin 30 which has minute irregularity on a front face, and split-face-izing the front face of aluminum, have been adopted Sufficient brightness was not obtained.

[0004]

[Problem(s) to be Solved by the Invention] Drawing 5 shows an operation of the liquid crystal display shown in drawing 4. It is reflected with A1 reflector 40, and the input light R1 passes the liquid crystal layer 50 and a glass substrate 80, and is taken out by the exterior (inside of air) 90 as the reflected light R2. However, in order to carry out total reflection of the light which carried out incidence at the include angle with the refractive index of air bigger [82] since the liquid crystal

layer 50 and the refractive index of a glass substrate 80 are usually about 1.5 to 1.0 than $\theta_{ai} \geq 41.8$ degrees (critical angle: θ_{ac}) of interfaces of glass/air, it will not be taken out by about 45% of the exterior of the reflected light. Although the light which carried out total reflection passes the liquid crystal layer 50, will carry out incidence of it to A1 reflector 40, scattered reflection will be again carried out to it, incidence of the part will be carried out to the interface 82 of a glass / air at an include angle smaller than a critical angle and it will be taken out outside. In case the liquid crystal layer 50 is passed, the light which advances to the method line of a major axis of the black color molecule 52 and parallel. Although hardly absorbed, since it is absorbed with the black color molecule 52, while the light which advances aslant to the direction of a major axis of the black color molecule 52 will repeat reflection between interface 82 and A1 reflectors 40 of glass/air, it will be absorbed in the liquid crystal layer 50. For the above reason, with the conventional structure, the external ejection effectiveness of light reflected with A1 reflector 40 was low, and sufficient brightness was not obtained. Therefore, the purpose of this invention solves the problem of decline in the external ejection effectiveness mentioned above, the light which carried out incidence to the reflector is taken out efficiently, and it aims at offering the reflective mold liquid crystal display which has sufficient brightness.

[0005]

[Means for Solving the Problem] That is, this invention is characterized by preparing a transparency insulating layer with a big refractive index compared with a liquid crystal layer on the reflector with which the front face was split-face-ized in a reflective mold liquid crystal display. In this invention, the ingredient with which a refractive index consists or more of 2.0 as said transparency insulating layer is desirable. For example, Ta₂O₅, ZnS, ZnSe, etc. are mentioned.

[0006]

[Function] If the refractive index of 1.5 and a transparency insulating layer is set to 2.25 for the refractive index of the refractive index 1.0 of air, glass, and a liquid crystal layer, the critical angle of air / glass interface and the critical angle of liquid crystal / transparency insulating-layer interface will become equal ($\theta_{ac} = 41.8$ degree). From a transparency insulating layer, the light which carried out incidence to the liquid crystal layer follows with a Snell's law, and is refracted. In order to carry out incidence to air / glass interface at an angle of below a critical angle, it is necessary to carry out incidence to liquid crystal / transparency insulating-layer interface at $\theta_{ai} < 26.4$ degree. On the other hand, total reflection of the light which carried out incidence to liquid crystal / transparency insulating-layer interface at $\theta_{ai} \geq 41.8$ degree is carried out, again, incidence is carried out to a reflector, scattered reflection is carried out and incidence of the part is carried out to liquid crystal / transparency insulating-layer interface at the include angle which fulfills $\theta_{ai} < 26.4$ degree conditions. Even if the absorption of light by the transparency insulating layer is very small compared with liquid crystal etc. and it repeats reflection between liquid crystal / transparency insulating layer, and a reflector, there is almost no absorption. Therefore, the rate that the reflected light is absorbed by the liquid crystal layer decreases remarkably with about 18% to about 55 conventional%. According to this invention, light absorbed by the liquid crystal layer as mentioned above can be lessened, and external ejection effectiveness can be raised.

[0007]

[Example] Drawing 1 is the sectional view of the reflective mold liquid crystal display in which the 1st example of this invention is shown. As for the reflective mold liquid crystal display in which the whole is shown by sign 1A, the pixel selecting switch 20 by the thin film transistor (TFT) is formed on the transparency insulation substrates 10, such as glass. The pixel selecting switch 20 by TFT consists of the gate electrode 21, gate dielectric film 22, the semi-conductor layer 23, a protective layer 24, the ohmic junctional zone 25, the source, and a drain electrode 26. The upper part of TFT 20 is covered in the acrylic resin layer 30, and the aluminum reflector 40 is arranged. The front face 42 of this reflector 40 is split-face-ized by being formed in the top face of the acrylic resin layer 30 with a concave convex.

[0008] As for the reflective mold liquid crystal display of this invention, the laminating of the transparency insulating layer 100 is carried out to the top face of a reflector 40. The upper part of the transparency insulating layer 100 is filled up with the guest host liquid crystal layer 50 containing the black color molecule 52, and the opposite transparent electrode 60, a color filter 70, and a glass substrate 80 are arranged. The guest host liquid crystal 50 containing a black color molecule forms the transparency insulating layer 100 with an ingredient with a refractive index higher than a liquid crystal layer to being about 1.5 refractive index. As an ingredient of the transparency insulating layer 100, Ta₂O₅ which has a refractive index ($n = 2.1$), for example is

adopted.

[0009] Drawing 3 is the explanatory view showing an operation of this invention. It is set as the refractive index $n=2.25$ of the transparence insulating layer 100 arranged in the upper part of a reflector 40, the refractive index $n=1.5$ of the liquid crystal layer 50, the refractive index $n=1.5$ of a glass substrate, and the refractive index $n=1.0$ of air 90. If the refractive index of each class is set up as mentioned above, both critical angle θ_{ac} of air / glass interface and critical angle θ_{ac} of liquid crystal / transparence insulating-layer interface will become $\theta_{ac}=41.8$ degree, and will become an equal critical angle. It is reflected with a reflector 40, and incidence of the incident light R1 is carried out to the liquid crystal layer 50 from the transparence insulating layer 100, and it is refracted with a Snell's law. In order to carry out incidence to air / glass interface at an angle of below a critical angle, it is necessary to carry out incidence to liquid crystal / transparence insulating-layer interface at $\theta_{ai}<26.4$ degree.

[0010] On the other hand, total reflection of the light which carried out incidence to liquid crystal / transparence insulating-layer interface at $\theta_{ai}\geq 41.8$ degree is carried out, again, incidence is carried out to a reflector, scattered reflection is carried out and incidence of the part is carried out to liquid crystal / transparence insulating-layer interface at the include angle which fulfills $\theta_{ai}<26.4$ degree conditions. Even if the absorption of light by the transparence insulating layer is very small compared with liquid crystal etc. and it repeats reflection between liquid crystal / transparence insulating layer, and a reflector, there is almost no absorption. Therefore, the rate that the reflected light is absorbed by the liquid crystal layer decreases remarkably with about 18% to about 55 conventional%. According to this invention, light absorbed by the liquid crystal layer as mentioned above can be lessened, and the external ejection effectiveness of the external ejection light R2 can be raised.

[0011] Drawing 2 shows the 2nd example of this invention. The pixel selecting switch 20 by the thin film transistor (TFT) is formed on the transparence insulation substrates 10, such as glass, like the 1st example by the reflective mold liquid crystal display in which the whole is shown by sign 1B. The pixel selecting switch 20 by TFT consists of the gate electrode 21, gate dielectric film 22, the semi-conductor layer 23, a protective layer 24, the ohmic junctional zone 25, the source, and a drain electrode 26. The upper part of TFT20 is covered in the acrylic resin layer 30, and the aluminum reflector 40 is arranged. As for the reflective mold liquid crystal display of this example, the laminating of the transparence insulating-layer 100A is carried out to the top face of a reflector 40. Transparence insulating-layer 100A is separated for every pixel through the separation section 102, the upper part is filled up with the guest host liquid crystal layer 50 containing the black color molecule 52, and the opposite transparent electrode 60, a color filter 70, and a glass substrate 80 are arranged.

[0012] If it is in this example, since transparence insulating-layer 100A which carries out a laminating is divided into the top face of a reflector 40 for every pixel, the leakage of the light to a contiguity pixel can be suppressed. A clearer display can be attained. Although the guest host liquid crystal containing a black color molecule is used for the liquid crystal layer as an example of this invention, the liquid crystal which is not what was restricted to this ingredient and contained coloring matter, such as red other than black and blue, can be used. Moreover, it is also possible to use not only guest host liquid crystal but the macromolecule distribution liquid crystal containing coloring matter.

[0013]

[Effect of the Invention] According to this invention, the light absorption by the liquid crystal layer can be decreased like the above-mentioned explanation, the external ejection effectiveness can be heightened, and the reflective mold liquid crystal display which has sufficient brightness can be offered.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The sectional view of the reflective mold liquid crystal display in which one example of this invention is shown.

[Drawing 2] The sectional view of the reflective mold liquid crystal display in which another example of this invention is shown.

[Drawing 3] It is the partial sectional view of the reflective mold liquid crystal display by this

invention, and signs that light reflects repeatedly in this equipment are shown typically.

[Drawing 4] The sectional view of the conventional reflective mold liquid crystal display.

[Drawing 5] It is the partial sectional view of the conventional reflective mold liquid crystal display, and signs that light reflects repeatedly in this equipment are shown typically.

[Description of Notations]

10 A transparence insulation substrate, source, a drain electrode, a 30 acrylic resin layer, 40 reflector, a 50 liquid crystal layer, a 60 opposite transparent electrode, a 70 color filter, a 80 glass substrate, 100 transparence insulating layer. 20 Pixel selecting switch 21 A gate electrode, 22 Gate dielectric film 23 Semi-conductor layer 24 Protective layer 25 Ohmic junctional zone 26